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Aging-Associated Changes in the Reproductive Function of *Drosophila melanogaster* Offspring

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Abstract—A comparative analysis of parental age-associated changes in the reproductive function and embryonic development has been performed for offspring of *D. melanogaster* imagoes of mutant (w^1_{CS} and w^1_{Or}) and wild-type (*Canton-S* and *Oregon-R*) lines. Fruit fly imagoes from three age groups (3-, 10-, and 20-day-old) were used in the experiment. Reciprocal crossings of young (3-day-old) imagoes to individuals from each age group were performed in order to identify the effects of maternal and/or paternal age on reproductive function parameters in the offspring. The effects of maternal and paternal ages on various reproductive function parameters in F_1 offspring were shown to vary between wild-type lines and mutant lines w^1_{CS} and w^1_{Or}, which is apparently due to genetic differences between the lines. The *white* mutation alone or combined with advanced parental age had a negative effect on fertility and viability characteristics in F_1 offspring and caused a predisposition to the development of dominant lethal mutations and death at the pupal stage, such that the emergence of less adapted and viable offspring in the population was prevented.

Keywords: aging, reproductive function, adaptation, *white* gene, *Drosophila*

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INTRODUCTION

Issues related to aging mechanisms in multicellular organisms and the effect of parental age on the reproductive function of the offspring remain incompletely characterized, despite recent discoveries and achievements in biology and medicine. Aging is a stochastic and irreversible process accompanied by reproductive function decline, decreased offspring fertility, and increased probability of aging-associated diseases and death of the organism [7]. Importantly, the mechanisms that underlie aging and determine the organism lifespan vary both between populations and within the same species. Moreover, certain insects, including *Drosophila melanogaster*, are capable of reproduction at late ontogenetic stages, regardless of reproductive function decline. This hinders the research on the patterns, causes, and underlying mechanisms of aging.

The reproduction of "senescent" *D. melanogaster* individuals, especially females, has a negative effect on the embryonic development and reproductive function of the offspring, including such phenomena as sexual behavior, ejaculate movement in the female's genital tract [16], fertilization and fertility [18], and lifespan at the postembryonic ontogenetic stages [12, 19]. This may be due to impaired oocyte formation, a decrease of the number and proliferative activity of germ cells and ovarian stem cells [22], and the accumulation of oocyte damage transmittable to the offspring [11]. Moreover, the activity of genes that control the maternal effect, segmentation, and homeiosis in animals and humans depends on age, the morphogen concentration in the oocyte cytoplasm decreases during aging, and other similar changes occur at the same time [13].

The mechanisms underlying differential gene expression in the developing organism are related to epigenetic pattern changes (such as genomic imprinting), the effect of cytoplasmic factors (for example, transcription factors, mRNA, and others), and environmental factors (such as the egg laying site and nutrient availability) [8]. Maternal effects are transmitted from the parents to the offspring. First, this phenomenon underlies the effects of age on the rate and extent of evolutionary changes in natural populations and causes phenotypic variation, and, second, it reflects the effect of maternal age on demographic patterns in the species [5]. The existence of the "paternal" effect and the influence of the age of both parents on the reproductive function of the offspring remain incompletely characterized. *Canton-S* and *Oregon-R* are the most commonly used wild-type lines, whereas lines with mutations in the *white* gene provide a convenient genetic background for the generation of insertion lines with the *P* element, including the widely